imaging system determines an angular position on the touch surface of the object coming in contact with the touch surface.

[0019] United States Patent Application 20060119589 by Rosenberg shows a haptic feedback feature for touchpads and other touch controls in which at least one actuator is coupled to the touch input device and outputs a force to provide a haptic sensation to the user contacting the touch surface. Output haptic sensations on the touch input device can include pulses, vibrations, and spatial textures, and the compliant suspension amplifies the haptic feedback.

[0020] United States Patent Application 20060016272 by Chang published Jan. 26, 2006 shows a thin film touch pad with opposed sensor elements that generate an electrical signal that is proportional to both the applied pressure and the surface area at the location of the applied pressure. As a result of the complementary orientation and overlapping for these sensor elements, the first and second sensor elements generate an asymmetric pair of signals that uniquely define the applied pressure by position and magnitude.

[0021] U.S. Pat. No. 6,879,318 by Chan et al. issued Apr. 12, 2005 shows a touch screen mounting assembly for a liquid crystal display panel LCD including a bottom frame, a backlight panel seated in the frame and that has a plurality of pressure-sensitive transducers mounted thereon, a liquid crystal display panel, and a top frame for exerting pressure when mounted to the bottom frame such that a plurality of compressible springs biases the LCD panel towards the bottom frame when touched or contacted by a user. The claims require the bottom and top frame assembly with backlight panel mounted therein on springs, and an overlying LCD panel.

[0022] Despite the availability of the existing sensing technologies mentioned herein, the prior art has been unable to provide a low-cost sensor assembly/solution having sufficient sensitivity, surface robustness, accuracy and form factor. Therefore, there is significant industrial applicability in the present invention which provides a force sensing technology which overcomes some of the deficiencies of the prior art.

[0023] A commercially viable force-based touch sensor for use with consumer equipment, such as computers, must be both inexpensive and precise. The precision required of such a device is the capability to sense both fingers and pens over a pressure range from about 1 gram to 500 grams or more, with a typical positional precision of +/−1 mm and a resolution of 400 dpi or more. When used in a smaller electronics device the sensor must also be thin, typically less than about 1 mm, and should also be capable of modular assembly for more-or-less "snap-in" construction. The force must in addition to be small and low cost, also be very durable. It needs to allow for millions of press-depress cycles as well as allow for high spikes in the applied force, such as if a device is dropped onto the floor, as well as allow for a wide temperature range, as wide as −40 C to +80 C, at least for storage.

[0024] FIG. **1** is a high level representation an electronic device **1**, such as a PDA or a cellular phone, having a touch screen assembly **2**. One skilled in the art should understand that the touch screen assembly **2** may be incorporated in cellular phones and personal digital assistants (PDAs), PC Tablets, as well as laptops, PCs, office equipment, medical equipment, or any other device that uses touch sensitive displays or panels.

[0025] The touch screen assembly **2** employs a touch surface comprising a pressure sensitive lens (PSL) **3** overtop (and preferably bonded to) an underlying LCD or OLED module **5**. The PSL **3** covers the LCD/OLED module **5** and may additionally cover static keys on the keypad **4**. It is noteworthy that the touch sensitivity area can be extended beyond the display module **5** display area. For example, in the example of FIG. **1** the PSL **3** also extends over a static printed keypad area **4**. Regardless of whether a user presses a key in the static keypad area **4** or some portion of the LCD/OLED module **5** area, exactly the same behavior is triggered. The exact "touch-coordinate" is calculated, the touch coordinate is interpreted, and proper control signal(s) are generated. If, for example, the user presses a Left-Arrow Command key, the corresponding left arrow command is generated. As will be described, the touch screen assembly **2** may optionally be equipped with a haptic response generator **12** along with the sensors **7**, such as a piezo element or a magnetic inductive coil. In this case whenever the PSL **3** is depressed a short vibration burst is generated by the haptic element **12** and the user can feel as if the "key" was pressed.

[0026] It is known to employ a mechanical differential-pressure touch screen system that uses a plurality of force sensors. For example, FIG. **1** is a high level representation an electronic device **1**, such as a PDA or a cellular phone, having a touch screen assembly **2**.

[0027] LCD/OLED module **5** has a plurality (such as, for example, four) differentially-mounted sensors **7** beneath it all connected to the electronic device **1** processor. This way, when a user touches the PSL **3**, the touch pressure is transmitted through the LCD/OLED module **5** into the sensors **7** where it is registered, processed, the exact "touch-coordinate" is calculated, and the touch coordinate is interpreted and proper control signal(s) are generated. Within this core context, two basic mechanical embodiments may be used. In one embodiment the sensors are mounted beneath the display module itself. Most conventional display screens (LCD or otherwise) are reinforced with a bonded protective lens. This lens is typically a 0.70 mm to 1.2 mm treated glass, protecting the LCD against cracks, scratching and also providing anti-glare coating. The existing glass lens serves as the primary touch surface, and the force imparted to the primary touch surface is transmitted through the display module and is detected by the differentially-mounted pressure sensors beneath the display module. Alternately, a separate free-floating lens may be used overtop the display module (independently suspended there over). The free floating lens straddles the display module and bears directly against the differentially-mounted pressure sensors.

[0028] Examples of both configurations are disclosed in International application no PCT/US2007/019606 filed 7 Sep. 2007. The touch sensitive lens may have some form of mechanical suspension, such as metal beams that suspend the lens and allow for a minor but unrestricted motion in the z-plane with a minimum or no motion in the xy-plane. There are typically four piezo-resistive force sensors in each corner that the floating lens rests on. In order to optimize performance, there may be a pre-loading of the lens through gasket or springs, that presses the lens down onto the force sensors with a preload weight typically greater then the weight of the lens itself. The piezo-resistive sensors are electrically connected via an amplifier to an analog to digital converter (ADC), typically one ADC with enough channels to support the number of sensors. The ADC is then connected via a digital bus, such as **12**C or SPI to a microcontroller or an application processor running positioning determination software. The software triangulates the force readings from